(12) UK Patent Application (19) GB (11) 2 316 445 (13) A

(43) Date of A Publication 25.02.1998

(21) Application No 9717072.4

(22) Date of Filing 12.08.1997

(30) Priority Data
(31) 19633190 (32) 17.08.1996 (33) DE

(71) Applicant(s)
Daimler-Benz AG

(Incorporated in the Federal Republic of Germany)

Epplestrasse 225, D-70546 Stuttgart,
Federal Republic of Germany

(72) Inventor(s)
Frank Duvinage
Hans Fausten
Rudiger Pfaff

(74) Agent and/or Address for Service
Jensen & Son
70 Paul Street, LONDON, EC2A 4NA, United Kingdom

(51) INT CL^6
F01P 3/12 // F02G 5/02, F02M 25/07

(52) UK CL (Edition P)
F1B B2LG B2LK B2L3A2 B2L4D
F4U U24A1 U24B2

(56) Documents Cited
GB 2303176 A GB 1592989 A US 4426848 A

(58) Field of Search
UK CL (Edition O) F1B, F4U
INT CL^6 F01P 3/12 3/20 5/10 11/04, F02D 21/08, F02G 5/00 5/02 5/04, F02M 25/07
Online: WPI

(54) Cooling system for EGR, integral with main engine cooling system

(57) A cooling system for an internal combustion engine has an engine cooling circuit with an engine radiator 1, a fresh-air supply conduit 10, which leads to the internal combustion engine 4, in which an exhaust gas turbocharger 12 is arranged, an exhaust gas return conduit 15, in which a cooling device 5 is placed. The cooling device 5 is integrated into the engine cooling circuit and device 5 is connected to the engine cooling circuit conduits 6, 19 via at least one branch conduit 7 and return conduit 8. In one embodiment a pump is used to circulate cooling medium to cooling device 5 (figure 2) and in another embodiment the cooling device 5 has its own radiator (figure 3). Exhaust gas conduit 15, after passing through the cooling device 5, opens into the fresh air supply conduit 10 leading to the supply conduit. Energy extracted by cooling device 5 may be used to heat the vehicle interior.

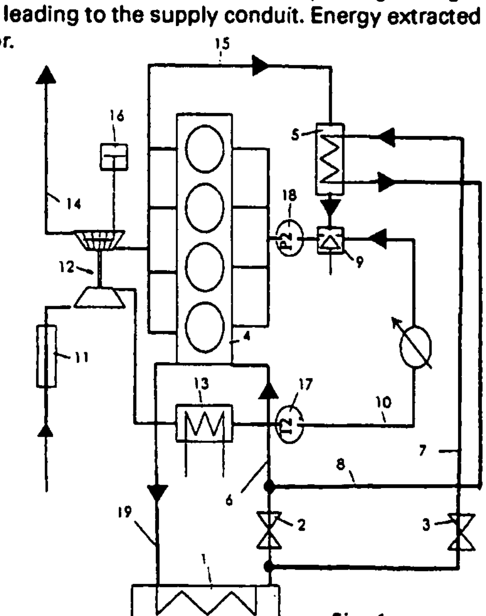

Fig.1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 316 445 A

1/3

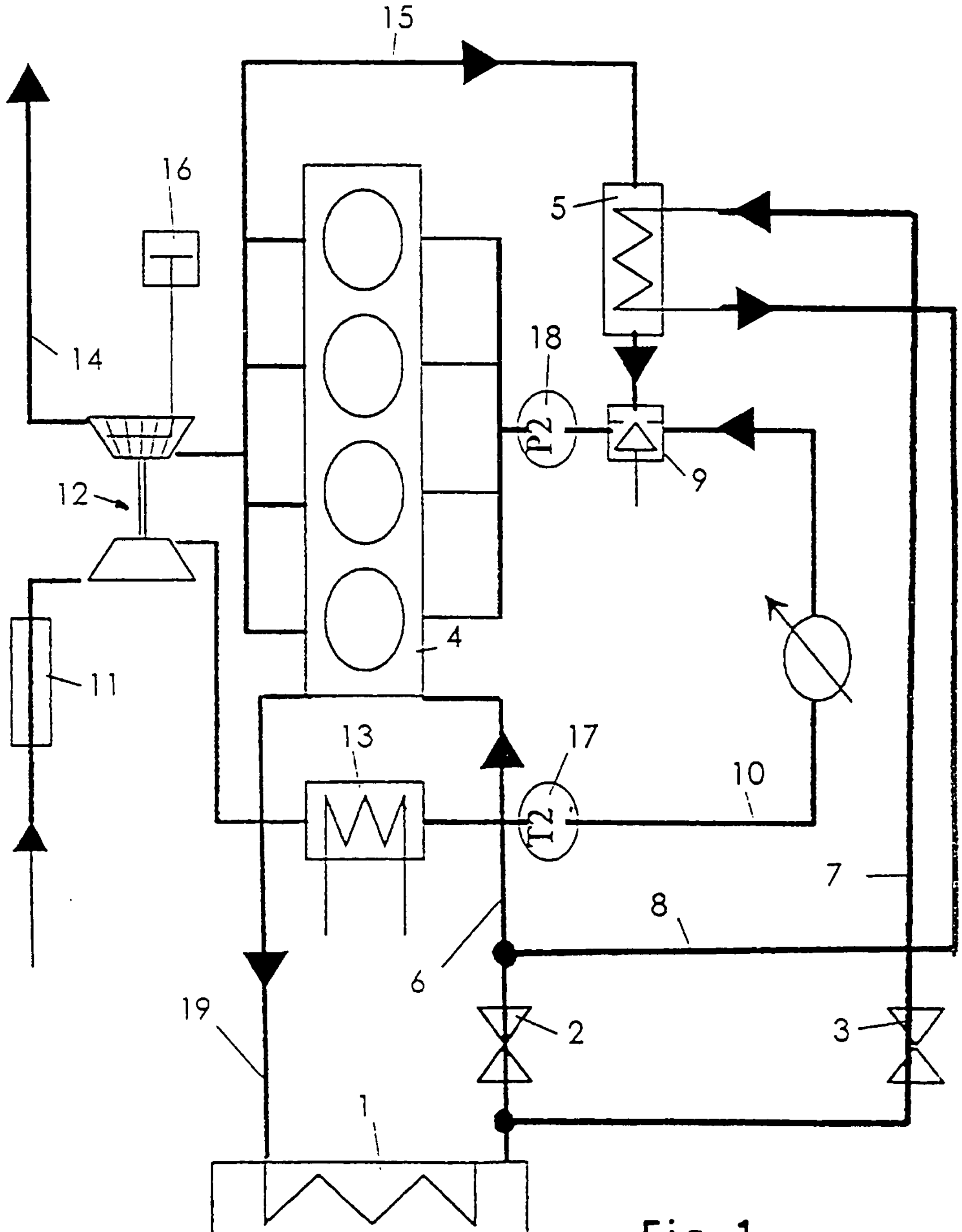

Fig.1

2/3

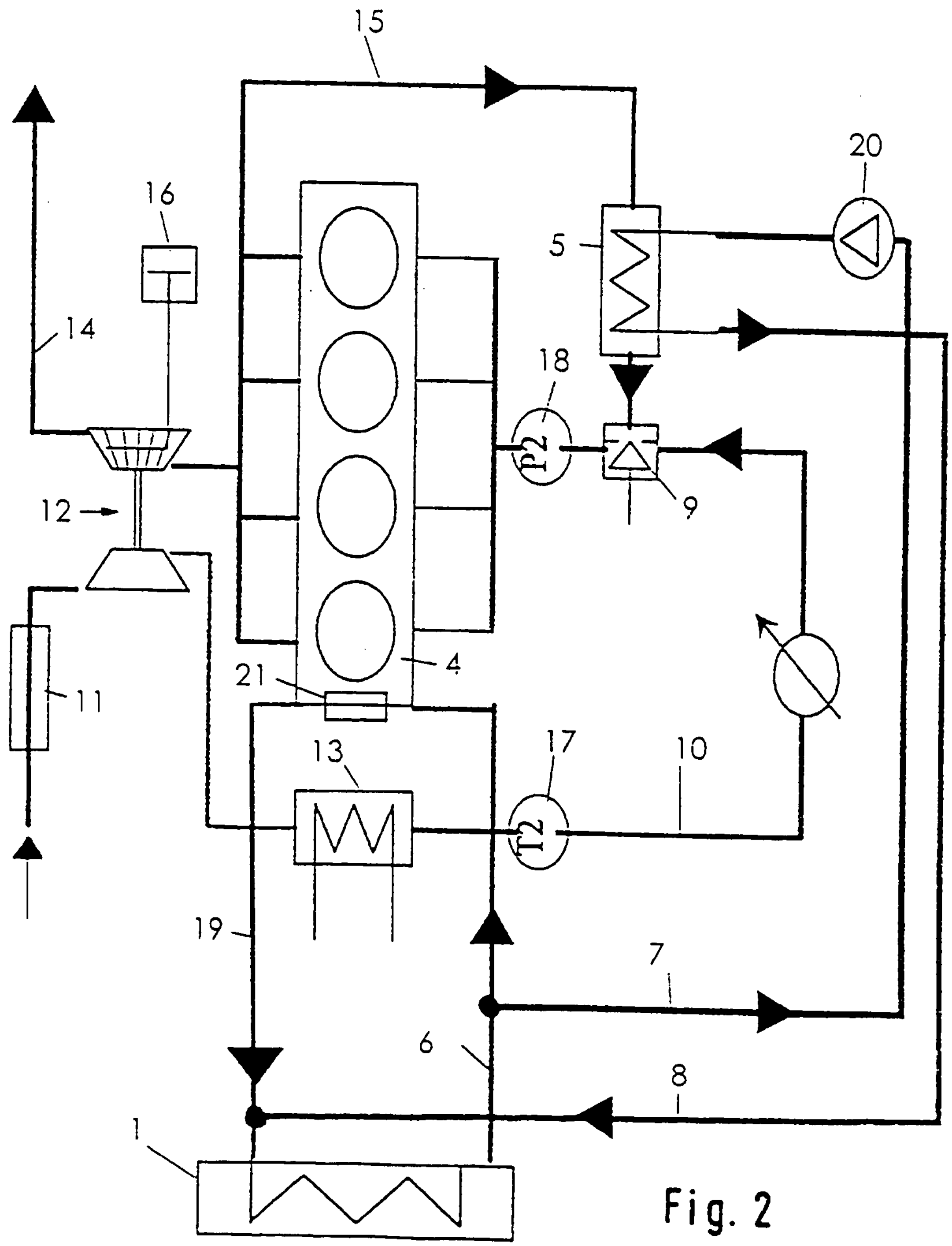

Fig. 2

3/3

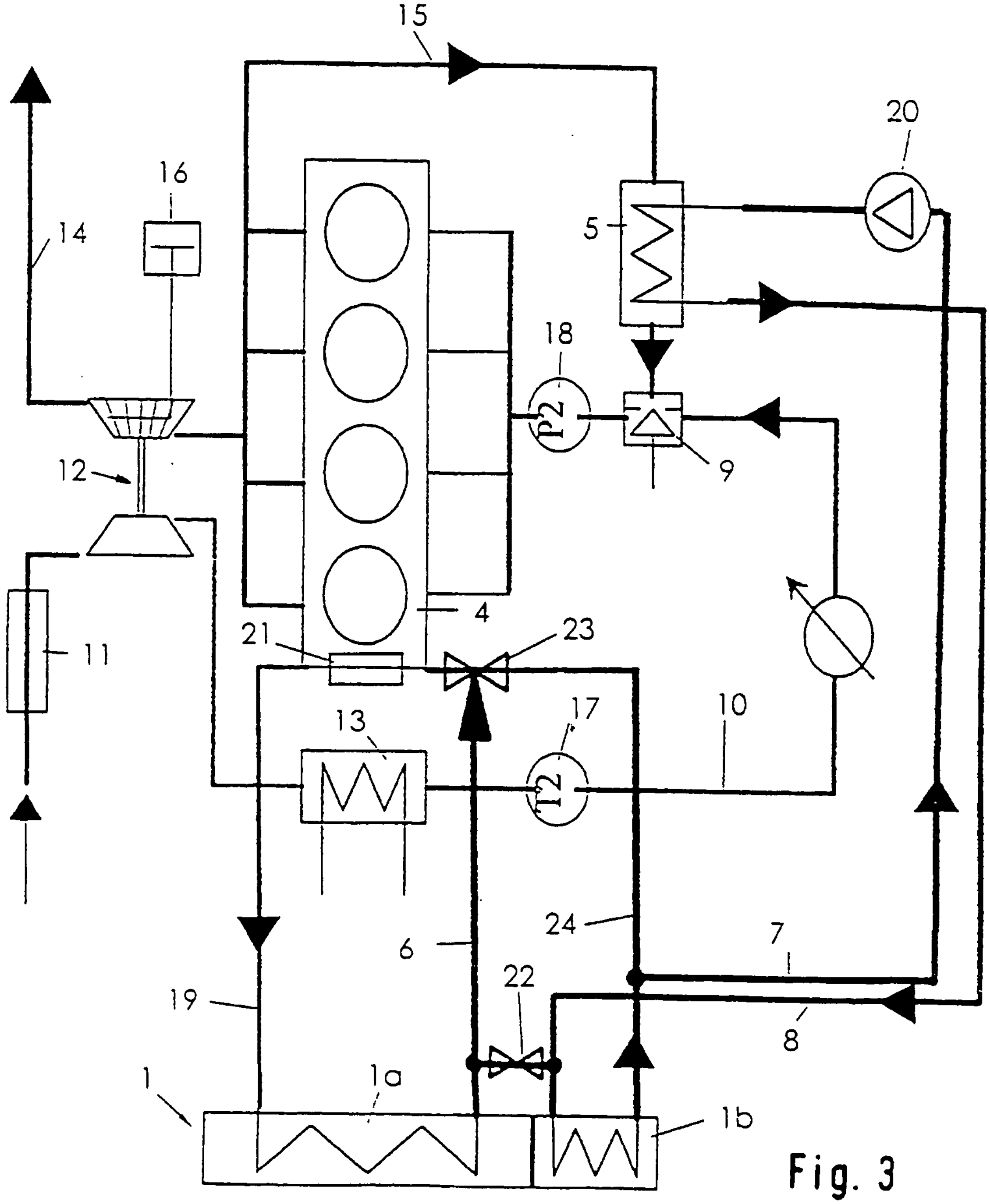

Fig. 3

2316445

Cooling system for an internal combustion engine

The invention relates to a cooling system for an internal combustion engine, with an engine cooling circuit which has an engine radiator, with a fresh-air supply conduit which leads to the internal combustion engine and in which an exhaust-gas turbocharger is arranged, and with an exhaust-gas return conduit, in which a cooling device is arranged.

DE-A-25 41 156 discloses a method for supercharging an internal combustion engine and the devices necessary for this purpose. In this case, the returned exhaust gases are introduced under pressure into part of a compressor, the said part likewise being under pressure, specifically at a point which is located downstream of the impeller blading in the direction of flow. According to the associated device, a cooling device is provided in a return conduit. This cooling device is to serve for cooling the exhaust gases before they are introduced into the compressor.

With the method described there, however, a reduction in pollutant emission, particularly in NO_X emission, is not possible or there is no thought of such a reduction.

DE 32 20 832 C2 discloses a method for determining the exhaust-gas return rate in diesel engines, a desired value for the exhaust-gas return rate being compared with an actual value relating to the state of the internal combustion engine. The exhaust-gas temperature is recorded as a measure of the load state of the internal combustion engine and is evaluated for the purpose of regulating the exhaust-gas return rate in the case of a changing desired value. In this case, a temperature-measuring point is also provided for determining this load state.

However, this method is highly complicated and, above all, has a large number of additional parts, such as sensors and electrical circuits. Furthermore, it is not suitable for reducing the NO_X emission.

DE 41 14 704 C1 describes a cooling system for a supercharged internal combustion engine for the two-stage cooling of the charge air compressed by an exhaust-gas turbocharger. There is provision, in this case, for branching off a coolant required in a secondary branch from a coolant stream leaving a high-temperature recooler, and for the coolant flowing through the internal combustion engine to flow

subsequently into the high-temperature recooler.

A disadvantage in this case, however, is that this cooling system, on the one hand, is of highly complicated design and, on the other hand, does not contribute to reducing the pollutant emission.

According to the prior art, in diesel engines the emission of NO_X particles is still very high. There have been attempts at the most diverse solutions for overcoming this problem. Thus, in one attempt, diesel engines are equipped with $DENO_X$ catalysts. However, this is an inadequate and, moreover, relatively cost-intensive solution in terms of the reduction in the NO_X emission.

The present invention seeks to reduce the pollutant emission, particularly the NO_X emission, of an internal combustion engine, particularly of a diesel engine.

According to the present invention there is provided a cooling system for an internal combustion engine, with an engine cooling circuit which has an engine radiator, with a fresh-air supply conduit which leads to the internal combustion engine and in which an exhaust-gas turbocharger is arranged, and with an exhaust-gas return conduit, in which a cooling device is arranged, wherein the cooling device is integrated into the engine cooling circuit, the cooling device being connected to conduits of the engine cooling circuit via at least one branch conduit and a return conduit, and the exhaust-gas return conduit, after passing through the cooling device, opening into the fresh-air supply conduit leading to the internal combustion engine.

The connection according to the invention of a cooling device to the engine cooling circuit via a branch conduit and a return conduit ensures that a cooling device is integrated into the engine cooling circuit. This provides a cooling system which makes it possible to reduce the NO_X and particle concentration. In the case of an appropriate arrangement, for example in the hot-water outrun, the waste heat from the exhaust gas can be utilized for heating the vehicle interior, this being advantageous particularly in the case of modern DE diesel engines which give off only relatively little excessive heat.

Advantageous refinements and developments of the invention emerge from the subclaims and from the exemplary embodiments described in principle hereafter with reference to the drawing in which:

Figure 1 shows a cooling system according to the invention with electrical valves

in a first embodiment;

Figure 2 shows a cooling system according to the invention with an electrical circulating pump in a second embodiment; and

Figure 3 shows a cooling system according to the invention with valves and an electrical circulating pump in a third embodiment.

According to Figure 1, a regulatable distribution of the liquid cooling stream to an internal combustion engine 4 and to a cooling device 5, which constitutes an exhaust-gas return cooler, is carried out from a vehicle radiator 1 via electrical valves 2 and 3. The valve 2 is located in a coolant supply conduit 6 of the engine circuit, the said supply conduit leading to the internal combustion engine 4. The valve 3 is located in a branch conduit 7 leading to the cooling device 5.

A performance graph relating to the effectiveness of the cooling device 5 can be regulated via the valves 2 and 3. Heat is supplied to the engine-cooling circuit of the internal combustion engine 4 via a return conduit 8 from the cooling device 5, this being advantageous particularly in the hot-running phase of the internal combustion engine 4. Fresh air is supplied to the internal combustion engine 4 via a regulated exhaust-gas return valve 9. The exhaust-gas return valve 9 is controlled by performance graph and is governed by the exhaust-gas return compatibility of the design of the internal combustion engine 4.

The fresh air is supplied in a known way via a fresh-air supply conduit 10, in which are arranged an air-mass meter 11, the compressor of an exhaust-gas turbocharger 12 and a charge-air cooler 13.

More charge mass can be supplied to the fresh-air circuit of the internal combustion engine 4 as a result of cooling by means of the exhaust-gas return cooler 5. This is achieved in that an exhaust-gas return conduit 15 is led from an exhaust-gas conduit 14, upstream of the turbine of the exhaust-gas turbocharger 12, to the cooling device 5 and, after corresponding cooling in the cooling device 5, exhaust gas is admixed with the fresh-air supply conduit 10 at the exhaust-gas return valve 9. An actuator 16 is provided in a known way for regulating the exhaust-gas turbocharger 12.

Furthermore, a temperature-measuring point 17 and a pressure-measuring point 18 as well as a return conduit 19 are also located in the cooling circuit.

Figure 2 illustrates an uncoupled circuit for the cooling device 5 with its

own electrical circulating pump 20. Furthermore, the components shown in Figure 1, which are therefore also provided with the same reference symbols in Figure 2, are also located in the cooling circuit of the internal combustion engine 4. In this embodiment, the valves 2 and 3 from Figure 1 are therefore replaced by the circulating pump 20.

If a thermostat valve 21 located in the engine cooling circuit of the internal combustion engine 4 is closed, as may be the case, for example, in the hot-running phase, maximum cooling rates may be achieved via the electrical circulating pump 20 by way of the internal circuit obtained as a result.

Since no heat occurs from the internal combustion engine 4 and the engine cooling circuit is closed relative to the return conduit 19 to the vehicle radiator 1, the engine cooling circuit flows only via the branch conduit 7 to the cooling device 5 and from there back via the return conduit 8 directly to the inlet region of the vehicle radiator 1. This circuit operates until the thermostat valve 21 opens. The fresh-air circuit for the internal combustion engine 4 and the exhaust-gas return take place according to the embodiment shown in Figure 1.

The aim of this exemplary embodiment is a maximum cooling rate during the hot-running phase. When the thermostat valve 21 opens, mixed operation is possible, but regulation of the electrical circulating pump 20 is also likewise possible. This depends on the particular instance of use.

Figure 3 shows a special form of the vehicle radiator 1. In this case, the latter is divided into two regions 1a and 1b.

Complete separation of the two circuits, namely the engine cooling circuit and the cooling circuit of the cooling device 5, can be achieved by means of a cut-off valve 22 together with a change-over valve 23. Appropriate interlinking is also possible, however, for optimizing purposes. The reason for this is that this makes it possible to avoid falling below the sooting temperature.

If the thermostat valve 21 is closed, the engine-side cooling circuit operates from the radiator region 1a via the cut-off valve 22 into the return conduit 8 of the cooling circuit of the cooling device 5 and consequently into the radiator region 1b. In this procedure, the two radiator regions 1a and 1b are connected in series. After passing through the radiator region 1b, cooled water is supplied to the engine via a

conduit 24 and the change-over valve 23. A vehicle radiator 1 divided into the radiator regions 1a and 1b is obtained in this way, the result of this being that the two radiator regions 1a and 1b may be appropriately combined according to the cooling requirement. In this case, the radiator region 1b may be located at any point on the vehicle.

In this embodiment, the cooling-air and exhaust-gas circuits correspond to the circuits illustrated in Figure 1.

There is also the possibility of retrofitting, since the vehicle radiator design does not have to be changed as a result of the invention. In particular, an exhaust-gas return does not take effect at the design point of the radiator, that is to say full-load operation and low speed. On the contrary, exhaust-gas return cooling takes effect only in the part-load range or in a range between the idling speed and 3/4 rated power speed, that is to say in the case of engine loads of between zero and 75% of maximum load.

Claims

1. A cooling system for an internal combustion engine, with an engine cooling circuit which has an engine radiator, with a fresh-air supply conduit which leads to the internal combustion engine and in which an exhaust-gas turbocharger is arranged, and with an exhaust-gas return conduit, in which a cooling device is arranged, wherein the cooling device is integrated into the engine cooling circuit, the cooling device being connected to conduits of the engine cooling circuit via at least one branch conduit and a return conduit, and the exhaust-gas return conduit, after passing through the cooling device, opening into the fresh-air supply conduit leading to the internal combustion engine.

2. A cooling system according to Claim 1, wherein the branch conduit branches off from the coolant supply conduit leading from the vehicle radiator to the internal combustion engine, and the return conduit of the cooling device is led back, upstream of the internal combustion engine, into the coolant supply conduit, regulating valves being provided in the coolant supply conduit and the branch conduit for the purpose of distributing the coolant stream.

3. A cooling system according to Claim 1, wherein a circulating pump is arranged in the branch conduit which branches off from the coolant supply conduit leading from the vehicle radiator to the internal combustion engine, and the return conduit is led from the cooling device into a return conduit leading back to the vehicle radiator.

4. A cooling system according to Claim 1, wherein the cooling device has its own coolant circuit with its own coolant radiator.

5. A cooling system according to Claim 4, wherein the coolant radiator is connected in series with the vehicle radiator.

6. A cooling system according to Claim 4 or 5, wherein the coolant radiator is flanged to the vehicle radiator.

7. A cooling system according to Claim 1, wherein the waste heat from the exhaust-gas heat exchanger is utilized for heating the vehicle interior.

8. A cooling system for an internal combustion engine, substantially as described herein with reference to, and as illustrated in, the accompanying drawings.

The Patent Office

9

Application No:	GB 9717072.4	**Examiner:**	David Glover
Claims searched:	1-8	**Date of search:**	11 November 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F1B; F4U

Int Cl (Ed.6): F01P 3/12, 3/20, 5/10, 11/04; F02D 21/08; F02G 5/00, 5/02, 5/04; F02M 25/07

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2303176 A	(Mercedes-Benz) see figure 1	
Y	GB 1592989	(Klöckner-Humboldt) see page 1 lines 36-52, figure 3 and page 3 lines 26-36	3, 4
X Y	US 4426848	(Stachowicz) see figure 1 and column 2 lines 46-48	X: 1 Y: 3, 4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		